

REMARKS/ARGUMENTS

Claims 1-23 are pending in the present application. The present amendments to claims 1-4 are being made to address matters of form or to place the application in better condition for allowance over the cited art. Accordingly, entry of the amendments is respectfully requested. The need for the amendments to claim 1 was not appreciated earlier since those amendments were prompted by the Examiner's comments in the Final Office Action and the telephone interview of November 24, 2003.

Claim Rejections - 35 U.S.C. § 102

The Examiner has rejected claims 1-5 and 7 under 35 U.S.C. § 102(b) as being anticipated by European Patent Application EP 658,927 to Kuke. This rejection is respectfully traversed.

Claim 1, as amended, specifically recites:

A method for producing bulk micromachined devices for use in Microelectromechanical Systems (MEMS), comprising the steps of:

providing a crystalline wafer with a front plane,

processing from said wafer at least one bulk micromachined device comprising at least one elongated opening or cavity, the opening or cavity having a longitudinal axis, so that **an angle is formed by said longitudinal axis and a line formed by intersection of the front plane of the wafer and a first cleavage plane**, said first cleavage plane being defined as a plane along which cleavage of the wafer is likely to occur, wherein **said longitudinal axis is not parallel with a second cleavage plane**, said second cleavage plane also being defined as a plane along which cleavage is likely to occur. (*Emphasis added*)

The differences between Kuke and claim 1 were discussed with the Examiner in the telephonic interview of November 24, 2003. In this interview, Applicants' representative, Paul Churilla, explained the aspects of claim 1 that are not disclosed in Kuke. Specifically, Kuke contains no discussion of forming its recess with **"a longitudinal axis, so that an angle is formed by said longitudinal axis and a line formed by intersection of the front plane of the wafer**

and a cleavage plane.” Applicants have also amended claim 1 to further clarify the distinguishing aspects of claim 1 over patents cited by the Examiner, which is discussed below.

With regard to claim 1, the longitudinal axis of the cavity of that claim **is not parallel with a cleavage plane** of a crystalline substrate in which the cavity is formed. As those of skill in the art would be aware, the $\langle 100 \rangle$ and $\langle 110 \rangle$ directions, as shown in Kuke, are coincident with cleavage planes. As may be seen in Figure 1 of Kuke, the longitudinal axis of the cavities 2 and 2' are situated along (parallel with) the $\langle 100 \rangle$ direction, a cleavage plane.

In contrast, claim 1, as amended, recites that **an angle is formed by the longitudinal axis (of a cavity) and a line formed by intersection of the front plane of the wafer (e.g., the top surface of the wafer) and a first cleavage plane (e.g., a plane in the $\langle 100 \rangle$ or $\langle 110 \rangle$ direction).** Claim 1, as amended, also recites that the **longitudinal axis is not parallel with a second cleavage plane.** These aspects of claim 1 will result in a cavity formed by such methods having much higher resistance to cleaving than the cavity disclosed in Kuke, which is desirable.

As one example of a cavity formed in accordance with claim 1, considering only the cleavage planes coincident with the $\langle 100 \rangle$ and $\langle 110 \rangle$ directions, such a cavity may have a longitudinal access that forms an angle with a line in the $\langle 100 \rangle$ direction, while the longitudinal axis is not parallel with the $\langle 110 \rangle$ direction, such as is shown in Figure 3a. Therefore, based on the foregoing, Kuke does not teach, describe or disclose all the elements of claim 1.

As was also discussed with the Examiner in the November 24, 2003 telephonic interview, **Kuke teaches an exact opposite approach with respect to the orientation of the longitudinal axis with respect to cleavage planes.** In this regard, use of the approach disclosed in Kuke would be disadvantageous for the manufacture of bulk micromachined MEMS devices, as such devices would be prone to cleaving in parallel with the longitudinal axis if that axis is also

parallel with the <100> direction, as is shown in Figure 1 of Kuke. Based on the foregoing, Kuke does not anticipate claim 1, and the rejection should be withdrawn.

Claims 2-5 and 7 depend ultimately from claim 1, and include all the limitations of that claim and any intervening claims. Therefore, these claims are patentable over Kuke on the same basis as claim 1 and, thus, the rejection should be withdrawn.

Claim Rejections – 35 U.S.C. § 103

Rejection on Kuke in view of Imaizumi

The Examiner has rejected claims 6 and 8 under 35 U.S.C. § 103(a) as being unpatentable over Kuke in view of U.S. Patent No. 6,440,616 to Imaizumi et al (hereafter “Imaizumi”). This rejection is now respectfully traversed.

As was discussed above with respect to claim 1, Kuke (the primary reference in all the proposed combinations) teaches forming an opening where the longitudinal axis of the opening is along a line coincident with a cleavage plane of a substrate (i.e., the <100> direction), while claim 1 recites a method for forming a cavity with a longitudinal axis that is not coincident with a cleavage plane. The cavity in Kuke is for the insertion of a component, such as for use as a motherboard. Kuke is not related at all to bulk micromachined devices or MEMS.

In her rejection, the Examiner cites Imaizumi as teaching an angle of less than 45 degrees. However, Imaizumi, like Kuke, is not related at all to bulk micromachining. Imaizumi is, in contrast, related to the flattening (planarization) of an epitaxial layer by forming “dents” in the surface of a substrate (See abstract). The depth of the “dents” in Imaizumi is about 20 μm (See column 5, lines 47-49). As is known, silicon substrates are typically on the order of 600 μm thick. Thus, the “dents” of Imaizumi are about 3.33% of the total thickness of a typical substrate. It will

be appreciated that such a “dent” is not consistent with bulk micromachining approaches. Bulk micromachining may be characterized in that three dimensional features are formed deep into the bulk of a crystalline substrate, such as on the order of 50% of the substrate thickness (e.g., about 300 μm for a 600 μm substrate), as is known in the art. The difference between cavities associated with bulk micromachining and cavities associated with typical semiconductor processes (e.g., for electrical circuit formation) is described in the specification of the present application on page 2, lines 4-9, which recites:

In general, it is true that cavities or openings are formed in [bulk] micromachined devices, which are large and deep in comparison to openings normally defined in semiconductor processing, such as contact or via holes, which have a diameter typically less than 5 μm and a depth less than 2 μm . Such large openings or cavities are responsible for a weakening of the wafer and increase the chance of the wafer breaking under the influence of stresses induced, for example, during processing.

In this respect, the 20 μm deep “dents” of Imaizumi are also not of sufficient depth to weaken a silicon substrate to the extent that cleaving is of greater concern than a substrate without such “dents.” As those of skill in this area will appreciate, the likelihood of cleaving becomes a significant concern for bulk micromachined devices due to the depth of the openings associated with such devices (e.g., on the order of 50% of the substrate thickness). In this regard, because neither Kuke nor Imaizumi relates to bulk micromachined devices or to the formation of cavities that are on the order of 50% of the overall thickness of a substrate, Applicants submit that one of skill in the art of bulk micromachining faced with the problem of substrate cleaving would not look to either Kuke or Imaizumi (or the combination of Kuke and Imaizumi) to solve that problem. Therefore, the rejection of claims 6 and 8 should be withdrawn.

Rejection on Kuke In View of Izuha

The Examiner has also rejected claims 9, 12, 15 and 18 under § 103(a) on Kuke in view of U.S. Patent No. 6,440,616 to Izuha et al (hereafter “Izuha”). This rejection is respectfully traversed.

The Examiner concedes that Kuke does not disclose subjecting the wafer to photolithography and cites Izuha to compensate for this deficiency of Kuke. Izuha, however, adds nothing to make up for the deficiencies of Kuke with respect to the forming of a cavity where **an angle is formed by the longitudinal axis (of a cavity) and a line formed by intersection of the front plane of the wafer (e.g., the top surface of the wafer) and a first cleavage plane (e.g., a plane in the <100> or <110> direction),** and that the **longitudinal axis is not parallel with a second cleavage plane,** as recited in claim 1 and discussed above. Izuha merely relates to a focus-monitoring process for photolithography and does not relate to cavity formation. (See Abstract) Therefore, Kuke and Izuha, alone or in combination, do not teach suggest or describe these aspects of claim 1.

Claims 9, 12, 15 and 18 depend ultimately from claim 1. Therefore, these claims include all the limitations of claim 1, and any intervening claims, and are not obvious on the same basis as claim 1. Thus, Applicants respectfully request that the Examiner withdraw the rejection of claims 9, 12, 15, and 18.

Rejection on Kuke In View of Izuha and Further In View of Marinaro

The Examiner has also rejected claims 10, 11, 13, 14, 16, 17 and 19-21 under § 103(a) on Kuke in view of Izuha and further in view of U.S. Patent 6,245,584 to Marinaro et al. (hereafter “Marinaro”). This rejection is respectfully traversed.

The Examiner concedes that Kuke and Izuha do not disclose a photolithography process comprising a contact printing step, a proximity printing step or a number of projection printing steps and cites Marinaro in this regard. As was discussed above Izuha adds nothing to compensate for the deficiencies of Kuke in rendering claim 1 obvious. In like manner, Marinaro also does not add anything to compensate for those deficiencies. In this regard, Marinaro is directed to a method for detecting adjustment error in a photolithography stepper and does not relate to cavity formation. (See Title and Abstract) Therefore, Kuke, Izuha and Marinaro alone or in combination, do not teach suggest or describe the previously discussed aspects of claim 1.

Claims 10, 11, 13, 14, 16, 17 and 19-21 depend ultimately from claim 1. Therefore, these claims include all the limitations of claim 1, and any intervening claims, and are not obvious on the same basis as claim 1. Thus, Applicants respectfully request that the Examiner withdraw the rejection of claims 10, 11, 13, 14, 16, 17 and 19-21.

Rejection on Kuke In View of Liu

The Examiner has also rejected claims 22 and 23 under 35 U.S.C. § 103(a) on Kuke in view of U.S. Patent 6,213,050 to Liu et al. (hereafter "Liu"). This rejection is respectfully traversed.

The Examiner concedes that Kuke does not relate to Microelectromechanical Systems (MEMS) and cites Liu in this regard. However, Liu relates to an apparatus for plasma immersion ion implantation, and does not relate whatsoever to the formation of cavities in a substrate. (See Title and Abstract) Liu merely states in column 1, line 43 that the immersion implantation apparatus has applicability to MEMS, for implantation steps, not etch related processes. Therefore, Liu also fails to make up for the deficiencies of Kuke, as have been previously described. Thus,

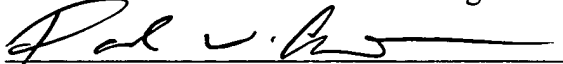
Kuke and Liu, alone or in combination do not teach suggest or describe the previously discussed aspects of claim 1.

Claims 22 and 23 depend from claim 1. Therefore, these claims include all the limitations of claim 1 and are not obvious on the same basis as claim 1. Thus, Applicants respectfully request that the Examiner withdraw the rejection of claims 22 and 23.

Conclusion

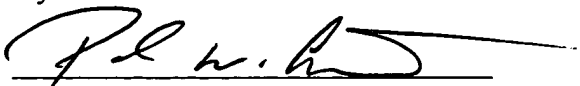
Based on the foregoing, Applicants believe that all claims pending in the above referenced application are in condition for allowance. Therefore, an indication of such allowance is respectfully requested. If there are any additional matters that the Examiner believes may be resolved by telephone, she is invited to contact the undersigned at phone number (360) 379-6514.

Date: Jan. 2, 2004

Respectfully Submitted,
McDonnell Boehnen Hulbert & Berghoff
By: 
Paul W. Churilla
Reg. No. 47,495

CERTIFICATE OF MAILING UNDER 37 C.F.R. § 1.8

The undersigned hereby certifies that the foregoing RESPONSE TO FINAL OFFICE ACTION MAILED ON NOVEMBER 4, 2003 is being deposited as first class mail, postage prepaid, in an envelope addressed to Mail Stop AF, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on this 2nd day of January 2004.


Paul W. Churilla